<u>What is claimed is:</u>

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1. A method of developing a three-dimensional tomographic mammography image of a breast, the method comprising:

(a) providing a device for performing cone beam volume tomography imaging, the device comprising a cone-beam radiation source and a flat panel detector;

(b) disposing the breast in a path of cone-beam radiation between the source and the detector;

(c) using the device to obtain a volume scan of the breast, the volume scan resulting in image signals; and

(d) forming the three-dimensional tomographic mammography image from the image signals.

2. The method of claim 1, wherein the volume scan is performed with a spatial resolution greater than 1 lp/mm.

3. The method of claim 1, wherein the volume scan is a single fast volume scan.

4. The method of claim 1, wherein step (c) comprises moving the cone-beam radiation source and the flat panel detector to define a data acquisition geometry.

5. The method of claim 4, wherein the data acquisition geometry is a circle geometry.

6. The method of claim 4, wherein the data acquisition geometry is a spiral geometry.

7. The method of claim 4, wherein the data acquisition geometry is a circle-plus-line geometry.

8. The method of claim 7, wherein the circle-plus-line geometry comprises a single line.

9. The method of claim 7, wherein the circle-plus-line geometry comprises a plurality of lines.

10. The method of claim 4, wherein the data acquisition geometry is a 180^0 plus cone angle circle scan.

11. The method of claim 4, wherein the data acquisition geometry is a 360^0 scan.

12. The method of claim 4, wherein the data acquisition geometry is a scan over N x 360^0, where N is a positive integer.

13. The method of claim 1, further comprising, before step (c), injecting a contrast medium into the patient.

14. The method of claim 1, wherein step (c) comprises taking at least one scout projection image for scatter correction.

15. The method of claim 14, wherein the at least one scout projection image is taken using a beam stop array.

16. The method of claim 1, wherein the flat panel detector is a detector capable of acquiring both static digital images and dynamic images.

17. The method of claim 16, wherein the flat panel detector is a thin-film transistor array flat panel detector.

18. The method of claim 16, wherein the detector is a digital area detector having a resolution of more than 1 lp/mm, and being able to acquire both static and dynamic digital images.

19. The method of claim 1, wherein step (d) comprises multi-resolution volume tomographic reconstruction from a single set of projection images.

20. The method of claim 1, wherein step (d) comprises using an image-based computer-aided diagnosis technique to detect and characterize a carcinoma in the breast.

21. The method of claim 1, wherein:

step (c) comprises taking an image of a volume of interest in the breast using a zoom mode of the detector; and

step (d) comprises using the image taken in the zoom mode to image the volume of interest.

22. The method of claim 21, wherein:

step (c) further comprises taking an image of the breast using a non-zoom mode of the detector; and

step (d) comprises removing streak artifacts from the image taken in the zoom mode by using the image taken in the non-zoom mode.

23. The method of claim 1, wherein step (d) comprises determining a volume of a tumor in the breast.

24. The method of claim 23, wherein the volume determined in step (d) is used to determine a volume growth of the tumor.

25. A device for producing a three-dimensional tomographic mammography image of a breast of a patient, the device comprising:

a gantry frame;

at least one motor for moving the gantry frame to form a data acquisition geometry;

a source of cone-beam radiation attached to the gantry frame to move with the gantry frame;

a flat panel detector attached to the gantry frame to move with the gantry frame, the flat panel detector being disposed in a path of the cone-beam radiation; and

a support on which the patient rests while the cone beam mammography projection images are taken, the support supporting the patient such that the breast is disposed between the source of cone-beam radiation and the flat panel detector;

wherein the at least one motor moves the gantry frame so that the flat panel detector takes a volume scan of the breast.

26. The device of claim 25, wherein the volume scan is performed with a resolution greater than 1 lp/mm.

27. The device of claim 25, wherein the volume scan is a single fast volume scan.

28. The device of claim 25, wherein the at least one motor comprises a motor for moving the cone-beam radiation source and the flat panel detector to define a data acquisition geometry.

29. The device of claim 28, wherein the data acquisition geometry is a circle geometry.

30. The device of claim 28, wherein the data acquisition geometry is a spiral geometry.

31. The device of claim 28, wherein the data acquisition geometry is a circle-plus-line geometry.

32. The device of claim 31, wherein the circle-plus-line geometry comprises a single line.

33. The device of claim 31, wherein the circle-plus-line geometry comprises a plurality of lines.

34. The device of claim 28, wherein the data acquisition geometry is a 180^0

plus cone angle circle scan.

35. The device of claim 28, wherein the data acquisition geometry is a 360^0 scan.

36. The device of claim 28, wherein the data acquisition geometry is a scan over N x 360^0, where N is a positive integer.

37. The device of claim 25, further comprising a dynamic collimator for controllably collimating the cone-beam radiation.

38. The device of claim 37, wherein the dynamic collimator comprises:

a first pair of leaves spaced apart in a first direction by a first distance; and

a second pair of leaves spaced apart in a second direction by a second distance, the first and second pairs of leaves being disposed relative to each other to define an aperture extending the first distance in the first direction and the second distance in the second direction.

39. The device of claim 38, wherein the dynamic collimator further comprises motors for moving the aperture.

40. The device of claim 39, wherein the motors move the first and second pairs of leaves to vary the first distance and the second distance.

41. The device of claim 25, further comprising:

an external computer for analyzing the image; and

a slip ring on the gantry frame for providing communication between the flat panel detector and the external computer.

42. The device of claim 41, further comprising a computer on the gantry frame, the communication between the flat panel detector and the external computer being carried out through the computer on the gantry frame.

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43. The device of claim 25, wherein the support comprises a table on which the patient lies while the cone beam mammography projection images are taken.

44. The device of claim 43, wherein the support further comprises a breast holder for holding the breast in the path of the cone-beam radiation.

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45. The device of claim 44, wherein the breast holder holds the breast in a cylindrical shape.

46. The device of claim 45, wherein the breast holder comprises a piston for pushing the breast to form the breast into the cylindrical shape.

47. The device of claim 25, further comprising a contrast injector for injecting a contrast medium into the patient.

48. The device of claim 25, further comprising means for taking at least one scout projection image for scatter correction.

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49. The device of claim 48, wherein the means for taking at least one scout projection image comprises a beam stop array.

50. The device of claim 25, wherein the flat panel detector is a detector capable of acquiring both static digital images and dynamic images.

~~51~~ 50. The device of claim ~~50~~ 49, wherein the flat panel detector is a thin-film transistor array flat panel detector.

~~52~~ 51. The device of claim ~~50~~ 49, wherein the detector is an digital area detector having a resolution of more than 1 lp/mm and being able to acquire both static and dynamic digital images.

53. The device of claim 25, further comprising a computer for performing multi-resolution volume tomographic reconstruction from a single set of projection images.

54. The device of claim 25, further comprising a computer for using an image-based computer-aided diagnosis technique to detect and characterize a carcinoma in the breast.

55. The device of claim 25, wherein:

the detector has a zoom mode and takes an image of a volume of interest in the breast using the zoom mode; and

the device further comprises a computing device for using the image taken in the zoom mode to image the volume of interest.

56. The device of claim 55, wherein:

the detector also has a non-zoom mode and takes an image of the breast using the non-zoom mode; and

the computing device removes streak artifacts from the image taken in the zoom mode by using the image taken in the non-zoom mode.

57. A dynamic collimator comprising:

a first pair of leaves spaced apart in a first direction by a first distance; and

a second pair of leaves spaced apart in a second direction by a second distance, the first and second pairs of leaves being disposed relative to each other to define an aperture extending the first distance in the first direction and the second distance in the second direction.

58. The dynamic collimator of claim 57, further comprising motors for moving the aperture.

59. The dynamic collimator of claim 58, wherein the motors move the first and second pairs of leaves to vary the first distance and the second distance.

60. A method of imaging a volume of interest in an object, the method comprising:

(a) providing a detector having a zoom mode and a non-zoom mode;

(b) taking a first image of the object using the non-zoom mode of the detector;

(c) taking a second image of the volume of interest using the zoom mode of the detector; and

(d) removing streak artifacts from the second image by using the first image.

61. The method of claim 1, wherein step (d) comprises forming a three-dimensional tomographic reconstruction of an x-ray linear attenuation coefficient of tissues in the breast.

62. The method of claim 61, wherein a carcinoma is detected in the breast in accordance with a difference in the x-ray linear attenuation coefficient between the carcinoma and a surrounding tissue in the breast.

63. The method of claim 1, wherein a tumor in the breast is distinguished as a carcinoma or a benign tumor in accordance with a border pattern of said tumor.

64. The method of claim 1, wherein steps (c) and (d) are performed multiple times to measure a change in a volume of a lesion, whereby a carcinoma is distinguished from a benign tumor in accordance with different growth rates between the carcinoma and the benign tumor.

65. The method of claim 13, wherein the contrast medium is used to assess lesion vascularity and enhancement rate in a lesion in the breast, whereby a carcinoma is distinguished from a benign tumor in accordance with different contrast enhancement rates between the carcinoma and the benign tumor.

66. The method of claim 13, wherein the contrast medium is used to assess breast tumor angiogenesis non-invasively.

67. The method of claim 1, wherein the three-dimensional image comprises a plurality of planes, and wherein a breast tumor in one of said planes is tomographically isolated from other objects in adjacent ones of said planes.

68. The method of claim 1, wherein the three-dimensional image obtained in step (d) is fused with real-time two-dimensional images obtained with the device in an image-guided biopsy procedure.

69. The device of claim 43, wherein the table has a breast hole for allowing the patient's breast to be disposed between the source of cone-beam radiation and the detector.

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70. The device of claim 69, wherein the table has two breast holes for both of the patient's breasts.

2 ~~71~~. The device of claim ~~70~~ 1, wherein the gantry is moved to image both of the patient's breasts simultaneously.

3 ~~72~~. The device of claim ~~70~~ 1, wherein the gantry is moved to image one of the patient's breasts at a time.

73. The device of claim 25, wherein the at least one motor comprises a linear motion motor for causing a linear relative motion between the gantry frame and the support.

74. The device of claim 73, wherein the linear motion motor moves the gantry frame.

75. The device of claim 73, wherein the linear motion motor moves the support.

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76. The device of claim 25, wherein the support comprises a support for supporting the breast while the patient is in a standing position.

77. The device of claim 25, wherein the source comprises a controller for controlling at least one of an exposure pulse length, an exposure timing and exposure pulse numbers of the cone-beam radiation.

~~78. The device of claim 77, wherein the controller dynamically changes an exposure level of the cone-beam radiation.~~

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13 ~~79~~. The method of claim 7, wherein the circle-plus-line geometry is a quasi-spiral geometry.

80. The device of claim 31, wherein the circle-plus-line geometry is a quasi-spiral geometry.

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